

Transactions of the Institution for information upon this intricate but extremely interesting subject.

Captain Kriloff's paper was of a completely mathematical character, and indeed was of far too abstruse a nature to follow during the reading. It depended on an appendix of many pages containing columns of figures which would require careful study to master.

Mr. Little's paper was of practical interest to those concerned in the carriage of grain.

The proceedings were brought to a close by the usual votes of thanks.

The summer meeting this year is to be held in Hamburg during the early part of June. Extensive preparations have been made for the reception of members, and there is no doubt the meeting will be of quite an international character. The success of last year's meeting in Paris has encouraged the Council to go abroad again.

It may be added that the Institution is increasing in numbers at a rapid rate, there being a greater addition to the roll of membership at this meeting than has ever before taken place.

RECENT WORK WITH RÖNTGEN RAYS.

SEVERAL important communications referring to work upon Röntgen rays have come before our notice during the past week. While some experimenters are perfecting the methods so as to develop the capabilities of the rays, others are investigating the physical characteristics pertaining to them, and in both directions of work clear advances have been made since our last eclectic statement of the contributions to the subject founded by Röntgen's discovery.

Prof. Alfred M. Mayer, of the Stevens Institute of Technology, has sent us the following account of experiments carried out by him on the polarisation of Röntgen rays.

"Of the remarkable properties of the Röntgen rays, the one of the greatest interest is that these rays are not polarisable; for this property shows that these rays, unlike those of light, are not propagated by vibrations transverse to the direction of their progress. To decide conclusively this point certain properties, shown by Röntgen's experiments, must be possessed by the substance which is to act on the Röntgen rays, viz. (1) a low density; (2) the substance must be very thin, and yet give complete polarisation to transmitted light. These two properties are eminently peculiar to herapathite, an iodo-sulphate of quinine. Its density is only 1.8, and crystals of herapathite of only 0.05 mm. in thickness, with their axes crossed at 90°, entirely obstruct the incident light, so that their crossed portions appear intensely black.

"Six discs of glass, 0.15 mm. thick and 25 mm. in diameter, were covered with crystal-plates of herapathite crossing one another at various angles. Where they crossed at right angles they gave a black field. These discs were fastened to the surface of a screen of compressed brown paper, which was found to be impervious to the actinic action of a powerful arc light acting during two hours, and placed 1 foot in front of the screen; the latter covering a sensitive photographic plate. On this screen were also placed three discs of the same glass, overlapping one another, so that 1, 2, and 3 thicknesses of the glass had to be traversed by the X-rays before they reached the photographic plate. These discs served as standards with which to compare the action of the X-rays on the discs covered with herapathite. On the same screen was also placed a square of yellow blotting-paper, $\frac{3}{4}$ mm. in thickness, having on its surface superposed herapathite crystals from two to four layers deep.

"This screen so prepared, and covering a sensitive plate, was exposed to the radiations of the Crookes' tube; in the first experiment for half an hour, in the second for one hour, and in the third for two and a half hours. On developing these plates there was not the slightest trace of the presence of the herapathites. The photographs of the glass discs had not the slightest mottling on their surfaces. Their surfaces appeared throughout to the unaided eye, and also when examined with a magnifying glass, with a uniform illumination and grain throughout. The herapathite, of the thickness used in these experiments, does not appear to screen at all the X-rays; for all the discs carrying it appeared exactly alike, in illumination and in grain, to the photograph of a similar disc having nothing on its surface. But the action of the rays on the square of blotting-

paper carrying the herapathites showed this in a more conclusive manner; for where this paper covered the photographic plate nothing was visible, except by the most careful scrutiny, and with the most favourable illumination, and then a mere ghost of the paper could be detected, but with no traces whatever of the herapathites.

"These experiments appear to have shown conclusively what Röntgen found by his experiments; viz. that the X-rays are not polarised by passing through doubly-refracting media."

At a recent meeting (March 3) of the Dublin University Experimental Science Association, Dr. J. Joly, F.R.S., described experiments made by him on the "Lenard-Röntgen" rays. He has found that the rays are reflected at the surface of mercury, lead, glass and wood. A photographic plate was enclosed in a light-tight carrier of millboard, upon the outside of which a copper ring was attached. This was exposed in the geometrical shadow of a thick lead plate to rays which entering a slot in the plate were reflected at the surface of mercury. An exposure of over an hour gave the shadowgraph of the ring. The position of this upon the plate indicated that the rays had approached from the direction of the reflecting mercury surface. Removing the dish of mercury, a much fainter image was obtained apparently from rays reflected from the wood beneath.

If the rays are received upon the carrier after passage between two parallel lead plates, the dark band formed upon the sensitive plate will be found to be bordered by heavy black lines. This was traced to a very complete reflection at grazing incidence to the lead plates, corresponding to the manner in which light is reflected at grazing incidence. A photographic plate exposed to light passing between the lead plates shows, in fact, a similar dark border; substituting glass plates for the lead, similar effects were obtained. This marked grazing reflection rendered it possible to concentrate the rays to an imperfect focus by causing them to pass through a conical tube of lead open at both ends, when a strengthening of the effects was formed on exposing at the narrow end of the cone.

Before the Royal Society on March 19, Lord Blythwood described some experiments which indicate that the X-rays can be reflected. He placed a vacuum-tube, A (Figs. 1-2), behind a lead screen, B B, 18 in. $\times$ 12 and $\frac{1}{4}$ thick. The screen had a 2-in. hole in it with a 2-in. pipe attached; 4 in. from the vacuum-tube was placed a speculum-metal mirror D, 4 in. $\times$ 2 $\frac{1}{2}$, at an angle of 45° with the lead screen; 4 in. from the mirror was a light-tight zinc box, E, with aluminium window, F; inside came first the objects, G, stuck on to a black cardboard, H, then I, the photographic plate. The following objects were photographed in about twenty minutes: (1) Some brass clock wheels. (2) A screw-cutting gauge. (3) Two lead discs. (4) The mirrors, being two pieces of speculum-metal used by Lord Blythwood to divide upon.

Two other papers were read before the Royal Society at the same meeting. In one of these, Mr. R. Erskine Murray described experiments made in the Cavendish Laboratory of the University of Cambridge, at Prof. J. J. Thomson's suggestion, in order to find whether the contact potential of a pair of plates of different metals is in any way affected by the passage of the Röntgen X-rays between the plates.

The vacuum bulb and induction coil for the production of the rays were enclosed in a box lined with metal, so that the plates and the apparatus used in measuring their contact potential difference should be screened from any direct electrical disturbances. At one side of the box there was a circular hole of about 3 cm. in diameter. The vacuum bulb was placed just inside this hole, and directed so that the rays should stream out through it in a direction perpendicular to the side of the box. In some experiments this hole was closed by a tinfoil screen, which allowed a large proportion of the rays to pass out while shutting in ordinary electrical disturbances. The plates whose contact potential difference was to be measured were placed at a short distance outside the box, in such a position that the rays could fall on them.

To measure their contact potential, Mr. Murray used the null method described by Lord Kelvin in his paper given to the British Association in 1880. In this method the value of the contact potential is found by measuring the amount of the counter potential which has to be applied to the pair of plates to reduce the potential difference between their opposing surfaces to zero. The counter potential introduced to effect this annulment must obviously be equal and opposite to their contact potential difference. Hence the numerical value of the latter is simply

that of the applied counter potential, but is of opposite sign. The plates were of zinc and tinfoil, the latter being mounted on thin ebonite to keep it flat. They were placed parallel to one another at a small distance apart, so that the rays fell perpendicularly on the back of the tinfoil plate, passed through it and the air space between them, and were absorbed by the zinc. The tinfoil plate was insulated and connected to the insulated quadrants of a Kelvin quadrant electrometer. The zinc was uninsulated, and was connected to the uninsulated quadrants of the electrometer. This plate was movable in a direction perpendicular to its plane, and could thus be drawn away from the tinfoil. If there was any electric potential difference between the opposing surfaces of the two plates, further separation caused a change in it which, reacting on the electrometer, deflected it.

In both cases its cause is probably the same. It is, no doubt, due to a want of electrical equilibrium among, and a partial dissociation of, the molecules of the gas.

In the third of the Royal Society papers referred to in the foregoing, Mr. C. T. R. Wilson gave an account of experiments made to determine the effect of Röntgen rays on cloudy condensation. The author has previously shown that cloudy condensation takes place in the absence of dust when saturated air suffers sudden expansion exceeding a certain critical amount. He now finds that air exposed to the action of Röntgen rays requires to be expanded just as much as ordinary air in order that condensation may take place, but these rays have the effect of greatly increasing the number of drops formed when the expansion is beyond that necessary to produce condensation. It is concluded that when the Röntgen rays pass through moist air they produce a supply of nuclei of the same kind as those which are always present in small numbers, or at any rate of exactly equal efficiency in promoting condensation.

At the Royal Dublin Society, on March 18, Mr. Richard J. Moss read a paper on the Röntgen X-rays. The mixed gases obtained by the electrolysis of hydrochloric acid were submitted to the action of X-rays. The apparatus employed was similar to that devised by Bunsen and Roscoe for their "Photo-Chemical Researches" (*Phil. Trans.*, vol. cccxlvii. p. 355). Every precaution was taken to ensure that the hydrogen and chlorine were in atomic proportions, and free from impurity. It was found that the X-rays, at a distance of 5 centimetres from the Crookes' tube, caused no combination of the hydrogen and chlorine. The combination of 0.1 per cent. of the volume of gas operated upon could not have escaped detection. The X-rays from the Crookes' tube employed were sufficient to produce fluorescence in a crystal of lithium rubidium platino-cyanide at a distance of 2 metres. The examination of a series of crystalline platino-cyanides showed that lithium rubidium platino-cyanide emitted the brightest light under the influence of the X-rays. The same order of luminosity was observed with ultra-violet light as with X-rays; and the colour of the fluorescence is similar whether excited by X-rays or by ultra-violet. Crystals of platino-cyanides which exhibited yellow and green fluorescence under the influence of the X-rays, behave as bodies opaque to those rays when photographed. Potassium platino-cyanide exhibits blue fluorescence, and if a crystal of this salt, separated from the sensitive plate by a sheet of white paper, be submitted to the action of the X-rays, it behaves as a luminous body and does not throw a shadow. The fluorescent light excited by the X-rays in this salt, acts more powerfully upon the sensitive plate than the direct X-rays.

Dr. John Macintyre has sent us an account of a further study and comparison of fluorescent screens. He says:

"I have tried several screens of calcium tungstate as recommended by Mr. Edison. The insoluble amorphous precipitate is fluorescent, but I have had it prepared in the crystalline form from two different sources; in both cases the screens gave much better fluorescence, and consequently better images. Messrs. Baird and Tatlock prepared the one form of crystalline salt, which was larger in the crystals than that prepared for me by Mr. I. Frank Bottomley. As there seems to be some difficulty in obtaining the crystalline form, it may be of interest to say that the latter gentleman prepared it according to the method of N. S. Manross (*"Liebig's Annalen,"* vols. 81-82). The method consisted in fusing together the anhydrous sodium tungstate and calcium chloride, the latter in excess. The sodium chloride and excess of calcium chloride are dissolved out, and crystalline calcium tungstate is left behind to be filtered off and dried. The crystals are a mixture of needles and octahedra, the latter only recognisable through the microscope.

"As far as I have been able to judge from the preparations given to me, potassium-platino-cyanide is the best salt. Of course, Mr. Edison may have a better method of preparing the crystals. With greater experience in screens, I am inclined to think that success depends very largely upon the way in which they are prepared. The paper or glass covering must be thickly and evenly coated. I have had an excellent screen prepared with the barium salt as well.

"My experiments have mainly been with the human skeleton; I have now seen shadows of all the bones and joints of the extremities, and what is more important, by placing the tube in the proper position I have seen distinct shadows of the spinal column and ribs of a man. The head is easily penetrated, and for surgical purposes all we now require in order to obtain greater

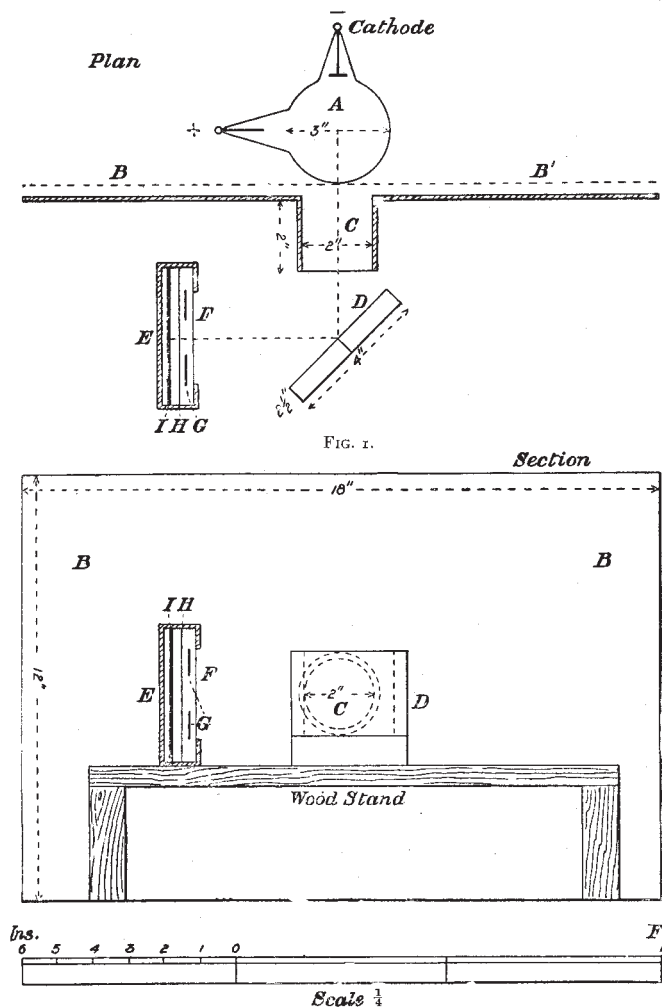


FIG. 1.—A, vacuum tube; B, lead plate, 18 in. × 12 in. $\frac{1}{4}$ in. thick; C, hole 2 in. diameter. Pipes 2 in. diameter × $\frac{1}{2}$ in.; D, speculum-metal mirrors; E, zinc box, 4 in. × 4 in., 1 in. deep; F, aluminium window; G, objects; H, black cardboard; I, photographic plate.

Experiments conducted with this arrangement led Mr. Murray to conclude that (1) the influence of the rays on the zinc and tinfoil plates does not cause any direct or sudden change in their contact potential, but that (2) the air through which the rays pass is temporarily converted into an electrolyte, and when in this condition forms a connection between the plates which has the same properties as a drop of acidulated water, namely, it rapidly reduces the potential between the opposing surfaces of the plates to zero, and may even reverse it to a small extent.

It is pointed out that this electrolytic property was found by Lord Kelvin (*"Electrostatics and Magnetism,"* Art. xxiii, §§ 412-414) to be possessed by the fumes from a burning spirit lamp.

definition in any part of the skeleton, is a more powerful source of X-rays; in other words, a step further in the preparation of Crookes' tubes. Even now the shadows obtained are good enough for many surgical purposes."

One of the most important discoveries in the new field of investigation is that certain phosphorescent substances emit rays capable of penetrating opaque materials and producing photographic effects. M. Henri Becquerel's experiments in connection with this matter have formed the subject of several valuable communications to the Paris Academy of Sciences, and have been referred to in our abstracts of the *Comptes rendus*, as well as in a brief note. We propose to give a full account of his work in a subsequent number of NATURE.

Mr. A. Hutchinson has sent us, under date March 23, the following account of experiments carried out by him in the Mineralogical Museum, Cambridge:—

"During the past few weeks I have found that quite a number of inorganic substances fluoresce when exposed to the action of the Röntgen rays; thus the following minerals all become more or less luminous, viz. diamond fluor-spar, apatite, autunite, scheelite, and a number of lead compounds, including cerussite, matlockite, anglesite, lanartrite, phosgenite; also lead chloride, lead iodide, lead glass, uranium nitrate and uranium glass. The fluorescence produced in most of these substances is very weak, but autunite, uranium nitrate and uranium glass, cerussite, some specimens of fluor spar, and some diamonds become fairly bright. The most effective substance which I have so far examined is, however, scheelite, the native tungstate of calcium. Colourless crystals of this mineral phosphoresce brilliantly under the action of the X-rays, the glow continuing for some seconds after the current is switched off, and when powdered they afford a screen which is at least as bright, if not brighter, than one prepared with barium platinum cyanide. It seems very possible that this substance may be 'the properly-crystallised' calcium tungstate of Edison's telegram, quoted in NATURE of March 19.

"It is, perhaps, interesting to note also that uranium nitrate, uranium glass, and the minerals autunite and torbernite are all capable of producing the remarkable effects discovered by M. Becquerel. Thus I have found that the radiations given out by uranium nitrate, when exposed to daylight, in an ordinary room are capable in twenty-four hours of penetrating sheets of aluminium 0.5 mm. thick, and I have obtained a shadow photograph of a coin by placing it on a plate, thoroughly protected from sunlight by light-tight envelopes, and covering it with a slab of uranium glass. This arrangement was allowed to stand near a window for a day; on developing the plate a distinct outline of the coin was found."

A decided step in advance in the application of Röntgen photography to medical science is marked by illustrations in the current issues of the *British Medical Journal* and the *Lancet*. The former journal contains a striking double-page plate of the skeleton of an infant, reproduced from a photograph by Mr. Sydney Rowland, and demonstrates at once the ability to portray the deep visceral region of the body by means of Röntgen rays. Mr. Rowland remarks that although no disease was present in the body of the child, the picture is none the less interesting from a scientific and medical point of view as being the first step towards the application of the method to the diagnosis of spinal and other deep affections. The photograph was obtained in fourteen minutes, and the age of the child was three months. The tube employed was the new focus tube, and it was placed some eight inches from the surface of the body so as to obtain sufficient spreading to cover the plate. It is pointed out that the positions of some of the soft organs are indicated on the picture; thus the heart and lungs are clearly silhouetted, and curiously enough the coils of intestine; while a clear space above them exhibits the place occupied by the stomach. A striking feature is that only the ossified portions of the bones in the arm and hand produce definite shadows, the undeveloped parts of the bones being but faintly visible.

The *Lancet* referred in the issue of March 21 to a photograph obtained through the body of a dead monkey, into whose kidney a biliary and uric acid calculus had been previously inserted. The current issue contains a plate reproduced from this photograph, and showing the spinal column and ribs with great clearness. The biliary calculus can hardly be distinguished from the kidney substance, but the uric acid calculus shows very clearly. The kidney itself is almost transparent to the rays, though not absolutely so.

In a letter communicated to the *Electrician*, Prof. G. M. Minchin gives a summary of the conclusions to which he has

been led with reference to the discharge of electrified bodies by the X-rays. The generally accepted opinion is that the X-rays discharge negative electricity from all bodies with great rapidity, and positive more slowly, leaving every body finally with a positive charge. Prof. Minchin, however, finds that "the X-rays charge some bodies positively and some negatively, and whatever charge a body may receive by other means, the X-rays charge it, both in magnitude and sign, to the charge which they independently give to the body." While gold, silver, copper, platinum and iron are all charged positively by the X-radiation, sodium, magnesium, tin, lead and zinc are charged negatively, the effect being in the case of some of these metals much more marked than in the case of the metals that become positively charged. Antimony appears to be almost neutral. Prof. Minchin considers that these observations tend to support the view that the X-rays are undulatory in character, and not of the nature of kathode rays.

Prof. Oliver Lodge writes to the *Times*:—"It may be worth just putting on record that during the past week I have seen fluorescence excited by Röntgen rays after they had penetrated the bodies of two men standing one behind the other in their clothes. Also, that we have succeeded in radiographing the details of a damaged vertebra in the spine of an adult patient at the Northern Hospital, Liverpool, with an exposure of half an hour; and have found a 'Murphy-button' in the intestine of another adult at the Liverpool Royal Infirmary with an exposure of ten minutes. A 'focus-tube' and a powerful ordinary induction coil were the means used."

Six good photographic reproductions accompany an article on Röntgen photography contributed by Mr. J. W. Gifford to *Knowledge*. One of the pictures of a mouse, and another of a sparrow, obtained on February 28, clearly locate the internal organs.

Finally, a number of important papers are referred to in the abstract of the *Comptes rendus* which appears in another column.

REPORT ON THE USE OF ANTITOXIN IN DIPHTHERIA.

A DETAILED report on the use of antitoxic serum in diphtheria, at the hospitals of the Metropolitan Asylums Board, has just been issued. It exhibits the results obtained during the year 1895 in all the six hospitals in which cases of diphtheria were treated, and is a most valuable testimony to the efficacy of the new treatment. From the summary of the report given in the *Times* we derive the subjoined general statistical results and conclusions.

Antitoxin was administered in rather more than three-fifths of the total number of cases admitted into the hospitals, and those for the most part representing the severer types of disease. The value of results obtained will be seen by taking the whole of the figures for 1895 and contrasting them with those of 1894, or rather with the first ten months of that year, previous to the introduction of antitoxin. This gives the following results:

Year.	Cases.	Deaths.	Mortality per cent.
1894 ...	3042	902	29.6
1895 ...	3529	796	22.5

The reduction in mortality of 7.1 per cent. below that of 1894—the lowest previously recorded in any year—must be fairly attributed to antitoxin, because nothing else was changed in the treatment; the average severity of the disease was about equal in the two years, and the proportion of juvenile, that is unfavourable, patients was somewhat larger in 1895 than in 1894. It may be added that diphtheria in both years alike means diphtheria as clinically, not bacteriologically, diagnosed. The essential conditions, therefore, were the same in the two periods. Had antitoxin been used in all cases in 1895, instead of in three-fifths only, the comparison would have been more symmetrical, but the numbers are sufficiently large to make it quite valid; and in this connection it is worth noting that those individual hospitals which made least use of the drug show the highest rate of mortality and the smallest reduction on their previous records. The broad conclusion reached is that in the year 1895 antitoxin saved 250 lives in London.

A complete examination and discussion of the statistics, leads to the following conclusions:—

The improved results in the diphtheria cases treated during the year 1895, which are indicated by the foregoing statistics and clinical observations, are:—